

INTERPRETING TEST DATA ON WATER FLOW IN A FAULT

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RESEARCH OBJECTIVES

To investigate the potential for fast flow through the Paintbrush nonwelded unit (PTn) at Yucca Mountain, Nevada, we carried out in situ field tests involving the release of water into a minor subvertical normal fault at Alcove 4 in the Exploratory Studies Facility (ESF) at Yucca Mountain. The zeolitically and argillically altered rocks of the lower Pah Canyon Tuff (Tpp) and the upper pre-Pah Canyon bedded tuffs (Tpbt2) are exposed in Alcove 4. Water was released at constant head into a packed-off interval straddling the fault within a horizontal borehole in the Tpp. The intake rate gradually fell from $\sim 200 \text{ ml min}^{-1}$ to 50 ml min^{-1} over a period of 41 hours of cumulative release time spread over 17 days of testing. Wetting was monitored using innovative electrical resistivity pads in a borehole 1 m below in the Tpbt2 in the fault interval and in the surrounding matrix.

APPROACH

Data analysis by numerical simulation and inverse modeling using TOUGH2/ITOUGH2 was used to simulate the flow tests. A single-continuum three-dimensional numerical grid with $\sim 11,000$ grid blocks was constructed to model the fault and the surrounding formation. The fault is modeled as a discrete feature with permeability $5 \times 10^{-11} \text{ m}^2$, while matrix permeabilities are 200 or more times smaller. Capillary pressure parameters for the van Genuchten model were derived from core data from nearby boreholes. Because of the sensitivity of moisture in the PTn to ventilation effects, the initial conditions for the test bed were established by mimicking the construction history of Alcove 4, including the construction of the slot in summer 1998. The alcove and slot 50% relative humidity boundary conditions are modeled using the Kelvin equation.

ACCOMPLISHMENTS

Simulation of the in situ flow tests showed that matrix imbibition alone was unable to account for the observed gradual decline in flow rate. Adding a time-dependent permeability function to model hypothetical effects of water on clay in the fault and fitting parameters to this function using ITOUGH2 resulted in a close fit to the data, as shown in Figure 1. Note in Figure 1 that the short-term intake rate declines are due to imbibition effects, whereas the longer timescale decline is due to permeability decrease associated with clay swelling or clay disaggregation and subsequent plugging of flow paths.

SIGNIFICANCE OF FINDINGS

The hypothesis that clay swelling or disaggregation and subsequent

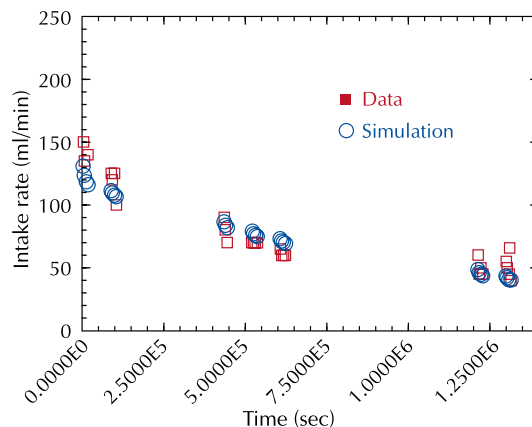


Figure 1. Data and simulated (best-fit) water-intake rate in borehole 12 assuming exponential decline in permeability.

plugging of flow paths in the fault decreases fault permeability remains to be tested in the laboratory. If the hypothesis is confirmed, the flow properties of the PTn may change with time as water content and water chemistry evolve due to repository heating or climate variation.

RELATED PUBLICATIONS

Salve, R., and C. Oldenburg, Water flow within a fault in altered nonwelded tuff, *Water Resour. Res.*, submitted.

ACKNOWLEDGEMENTS

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